

# Development of microbial cell factories for consolidated bioprocessing by engineering biology platform

Akihiko Kondo<sup>1,2,3</sup>

<sup>1</sup>Graduate School of Science, Technology and Innovation, Kobe University,

<sup>2</sup>Department of Chemical Science and Engineering, Graduate School of Engineering, Kobe University, 1 -1 Rokkodai-cho, Nada-ku, Kobe, Hyogo 657-8501, Japan.

<sup>3</sup>Cell Factory Research Team, RIKEN Center for Sustainable Resource Science, 1-7-22 Suehirocho, Tsurumiku, Yokohama, 230-0045, Japan

e-mail: akondo@kobe-u.ac.jp

In order to construct sustainable biorefineries, which produce variety of biofuels and bio-based chemicals from non-food biomass, consolidated bioprocessing (CBP), which integrates enzyme production, saccharification and fermentation into a single process, is a promising strategy. One of the key technologies to develop microbial cell factories for CBP is cell surface engineering, which is a powerful tool to express enzymes on the cell surface for conversion of biomass into sugars. We have developed various cell surface display systems in yeast, bacteria and fungus and showed the direct fermentation of biomass. To design novel metabolic pathways for conversion of sugars to target chemicals, we have developed computer simulation tools. To efficiently construct cell factories by re-write genome based on designs, we have developed the platform technologies such as genome editing and a large gene cluster synthesis systems and are going to integrate to set up the automated systems. By tethering the DNA deaminase activity to nuclease-deficient CRISPR/Cas9 system, a genome editing tool that enables targeted point mutagenesis have developed (termed Target-AID or Base Editor). In addition, an efficient DNA assembly method, namely, Ordered Gene Assembly in *B. subtilis* (OGAB) method have developed. OGAB method can assemble more than 50 DNA fragments to construct up to 100 kb DNA in one-step using *B. subtilis*. An automated metabolomics analysis system has also been developed to analyze the performance of cell factories in more accurate and high throughput manner. We have integrated these technologies to construct engineering biology platform to quickly construct microbial cell factories for CBP. We are applying this platform for construction of various cell factories.

**Dr Akihiko Kondo**



- <sup>1</sup> Dean & Professor, Graduate School of Science, Technology and Innovation, Kobe University,
- <sup>2</sup> Professor, Department of Chemical Science and Engineering, Graduate School of Engineering, Kobe University
- <sup>3</sup> Team Leader, Cell Factory Research Team, RIKEN Center for Sustainable Resource Science

### **Education:**

- B.S. Chemical Engineering, Kyoto University, Kyoto, Japan 1983
- M.S. Chemical Engineering, Kyoto University, Kyoto, Japan 1985
- Ph.D. Chemical Engineering, Kyoto University, Kyoto, Japan 1988

### **Professional Career:**

- 1988-1995: Associate Professor, Department of Applied Chemistry, Kyushu Institute of Technology
- 1995-2003: Associate Professor, School of Engineering, Department of Chemical Science and Engineering, Kobe University
- 2003- : Professor, School of Engineering, Department of Chemical Science and Engineering, Kobe University
- 2012- Team Leader, RIKEN Center for Sustainable Resource Science
- 2016- Dean & Professor, School of Science, Technology and Innovation, Kobe University

### **Research Interests:**

- Biorefinery: Production of biofuels, chemicals and materials from biomass
- Metabolic engineering and engineering biology
- Genome editing and genome synthesis to re-write genome

### **Selected Publications**

1. Hasunuma T. et al., *Biotechnology advances* 30 (6), 1207-1218 (2012)
2. Araki M., et al., *Bioinformatics*, **31(6)**, 905-911 (2015)
3. Nishida K. et al. *Science*, **353**, aaf8729 (2016).
4. Shimatani Z. et al., *Nature Biotechnology*, **35(5)**, 441-443 (2017).
5. Tsuge, K. et al., *Scientific Reports*, **5**, 10655 (2015).
6. Noda S et al., *Nature Communications*, 8(1): 1153 (2017)
7. Vavricka, CJ., et al., *Nature Communications*, 10 (1), 2015 (2019)
8. Vavricka, CJ., et al., *Trends in Biotechnology*, in press(2019)